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EFFECT OF ELECTRIC CURRENTS INDUCED IN THE EARTH, ON THE SIZE AND FORM OF MIDNIGHT SUDDEN COMMENCEMENTS OF MAGNETIC STORMS

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EFFECT OF ELECTRIC CURRENTS INDUCED IN THE EARTH, ON THE SIZE AND FORM OF MIDNIGHT SUDDEN COMMENCEMENTS OF MAGNETIC STORMS

(Vliyaniye elektricheskikh tokov, indutsiruyemykh v Zemle, na formu i velichinu vnezapnykh nachal magnitnykh bur')

Geomagnetizm i Aeronomiya,
Tom II, No. 2, 367–368
Izd-vo A. N. SSSR, Moskva 1962

by K. G. Ivanov

The sudden commencements of magnetic storms (SSC), observed near the local midnight have the simplest form [1]. They constitute in the horizontal component an initial fast increase (3 to 6 minutes) of the component from the unperturbed to a certain maximum value, and a subsequent smoother decrease of the component (during 6 to 10 minutes) by ~ 30 percent of the SSC amplitude. Let us note that this ensuing smoother decrease may be often distorted, as it may be seen from the magnetograms of the "night" observatories Maytun , where the sensitivity of the H-variometer is somewhat increased by comparison with the H-variometer sensitivities at other observatories, and from the magnetograms of the high-latitude Srednikan observatory. Distortions of the ensuing field decrease were also observed at Maytun [4]. Sometimes these distortions ase so big that the subsequent decrease is almost entirely concealed by them. To this our attention was called by V. I. Afanas'yeva.

It is assumed [2], that the initial rise is induced by the superimposition upon the Earth magnetic field of the current magnetic field induced in the corpuscular stream at time of its

nearing the Earth. The following decrease cannot be explained by a decrease of these currents, for, according to [3], their attenuation time is very great. Let us assume that this is caused by the attenuation of electric currents induced in the Earth at time of sudden commencements of magnetic storms. During that time, the currents induced in the Earth, reduce the magnitude of SSC inside the Earth and increase it at its surface. Upon cessation of SSC, these currents attenuate, diminishing the value observed at the Earth's surface, which takes place in reality.

Thay is why the form of magnetic storm sudden commencements near midnight must differ in the tellurogram recordings from the form of the very same SSC registered in magnetograms. It must consist of an initial increase of the gradient of the electric field's potential in the direction East — West (during the time of field accretion in the magnetogram), and of a following decrease of the potential's gradient till the initial value for the time of the ensuing field decrease in SSC on the magnetogram.

The comparison of SSC magnetograms and tellurograms according to the materials of the magnetic observatory at Maytun for the IGY period [4], has shown that SSC beginning near midnight, have the expected form in tellurograms. This confirms the correctness of the assumption that the following decrease in the field of the SSC in the magnetogram is caused by the attenuation of currents induced in the Earth by the sudden commencement of the magnetic storm. It is well known [5], that the field of currents induced in the Earth by any variation of external origin, constitutes ~30% of the field of a variation observable at the Earth's surface. The strength of the electric field E, induced by a sudden commencement on Earth, may be estimated by the formula $E \sim (dH)\, l/(dt)$, [6], where dH/dt is the rate of H-component variation during (SSC), l — characteristic dimension of the region in which the induced currents flow.

Having admitted that l is of the identical order with the penetration depth of the SSC in the Earth, and that

$$(l \sim \sqrt{1/\sigma\omega}) \quad [6]$$

where σ is the Earth's conductance, ω is frequency of field's variation during the SSC, we have :

$$E \sim \frac{dH}{dt}\sqrt{\frac{1}{\sigma\omega}}.$$

It is well known [4], that as an average,

$$dH/dt \sim 10^{-6}\ un.\ CGSM\ sec^{-1}, \omega \sim 2{,}5 \cdot 10^{-2}\ sec.^{-1}.$$

Admitting that $\sigma \sim 10^{-14}$ un.CGSM, we have $E \sim 60$ mV/km, which coincides by the order of magnitude with the observed values of the electric field's strength (~ 100 mV/km). The intensity of currents' magnetic field (H), that are induced in the Earth during SSC, will be estimated by the formula $H \sim 2\pi\sigma E$ [6]. At $\sigma \sim 10^{-14}$ un . cGSM, $E \sim 60$ un. CGSM($l \sim 5 \cdot 10^7$ cm), we have $H \sim 2 \cdot 10^{-4}$un. CGSM, which coincides by the order of magnitude with the value of negative variations of the field observed after the SSC.

As a result of this brief study one may state, that the magnetic field of currents induced in the Earth during SSC, is revealed in a form of a negative after-effect in the SSC, that these currents increase the value of the near-midnight SSC by ~ 30 percent, and impart them a "hook-like" form.

The author is grateful to P. A. Vinogradov and V. I. Afanas'yeva for their discussion of the results of the present work.

****** E N D ******

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24 June 1962.

REFERENCES

1. K. G. IVANOV. Geomagn. i Aeron. I, No. 2, 232-235, 1961

2. S. CHAPMAN, V. C. A. FERRARO, Terr. Magn. and Atmos. Electr. 36, 77, 1931

3. S. B. PIKEL'NER. Sb."Fizika solnechnykh korpuskulyarnykh potokov i ikh vozdeystviye na verkhnyuyu atmosferu Zemli." (Physics of solar corpuscular streams, and their effect upon the upper atmosphere of the Earth). Izd-vo A. N.SSSR, 1955.

4. CATALOGUE OF DISTURBANCES. Rept. Ionosph. Res. Japan, 11-13, 1957-9.

5. N. P. BEN'KOVA. Magnitnyye buri i sistemy elektricheskikh tokov. (Magnetic Storms and Electric Current Systems). Trudy "NIZMIR", vyp. 10 (20), 3, 1953.

6. L. D. LANDAU, E. M. LIFSHITS. Elektrodinamika sploshnykh sred. (Continuum Electrodynamics) Gostekhteoretizdat, M., 1957

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